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U.S DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
HUBBELL TRADING POST NATIONAL HISTORIC SITE, ARIZONA
MAINTENANCE, OPERATION, AND SAFETY OF DAMS PROGRAM

2001 Joint National Park Service and Bureau of Reclamation
Literature Search and Review and Site Visit Report

Hubbell Reservoir

Prepared By
Technical Service Center
Bureau of Reclamation
Denver, Colorado
January 2003



NATIONAL PARK SERVICE
WATER RESOURCES DIVISION
FORT COLLINS, COLORADO
RESOURCE ROOM PROPERTY

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MEMORANDUM

To: Regional Director, Intermountain Region, National Park Service,
Department of the Interior, P.O. Box 25287, Denver, CO 80225-0287
Attention: Denver Support Office, Facility Management, Design, and
Engineering Branch, NPS Maintenance, Operations, and Safety of Dams
(MOSD) Program Coordinator, Phil Ayers

From: Kevin Gagner, Civil Engineer, P.E.
Inspections and Emergency Management Group

Subject: Transmittal of Literature Search and Review and Site Visit for Hubbell Reservoir
(AZ82914)¹ [645]², and Updated National Park Service (NPS) Dams Inventory
Printout - Safety Evaluation of Existing Dams (SEED) Program - National Park
Service - Hubbell Trading Post National Historical Site, Arizona

Attached are two copies of the report for the National Park Service, Intermountain Regional Office covering the above mentioned dam, which was examined in May 2001. The purpose of the site visit was to evaluate the condition of the dam, document current operation and maintenance activities, update the NPS Dams and Related Floodplain Inventory Report, and assess the public safety hazard potential at the sites. Draft copies of this report were provided to offices involved with the dam for review.

This activity is the result of an interagency agreement between the National Park Service and the Bureau of Reclamation, in accordance with the Departmental Manual, Part 753; NPS Management Guidelines-2001, NPS Special Directive 87-4, Dams and Appurtenant Works - Desk Reference Manual for Maintenance, Operation and Safety, and NPS-40, Dams and Appurtenant Works: Maintenance, Operation, and Safety, Chapter 6, Section C, "Periodic Inspection Program." These guidelines discuss the management of NPS structures and monitoring of non-NPS structures which affect the National Park System and Related Areas.

¹Parentheses contain the National Inventory of Dams identification number for the dam.

²Bracket contains the NPS dam inventory number.

No annual informal inspection reports, Operation and Maintenance logs, plans, or updated inventory printouts on the examined dams were available for review during these examinations.

It was discovered during the examination of this dam that the facility is outside the boundaries of the Hubbell Trading Post National Historical Site, and is owned by the Bureau of Indian Affairs (BIA). During preparation of this report, it was also discovered that the dam has a downstream low hazard potential rating, and that BIA anticipates rehabilitating the dam for use as part of a larger irrigation system, and as part of the Hubbell Trading Post interpretive program. In accordance with NPS 40, NPS observers should be present during inspection of non-NPS dams with high or significant hazard potential classifications if the dams are located immediately adjacent to or within park boundaries. At this time, this requirement is not considered necessary at Hubbell Reservoir. However, if the anticipated rehabilitation of the facility includes increasing the reservoir storage capacity, the downstream hazard potential classification should be revisited. A NPS Maintenance Management Program should be utilized to plan and record monitoring of non-NPS dams. Each NPS or non-NPS dam should have a location code so that management can utilize the Location Maintenance Report to identify all work activities performed on the NPS dams and on monitoring of the non-NPS dams.

This report includes a report narrative, conclusions, recommendations, photographs, a list of personnel in attendance during the site visit, and a current NPS inventory sheet (revised as appropriate).

Thank you for this opportunity to participate in this activity and to assist the National Park Service. If you have any questions or if we can be of further assistance, please contact Kevin Gagner at (303) 445-2746.

Attachments

cc: Director, National Park Service, Department of the Interior, Park Facility Management Division,
Org. Code 2420, 1849 C Street, N.W., Mail Stop 7252-MIB, Washington DC 20240,
Attention: NPS Maintenance, Operations, and Safety of Dams (MOSD) Program Officer
(w/att)

Hubbell Trading Post National Historic Site,
P.O. Box 150
Ganado, AZ 86505
(w/att)

Director, Denver Service Center, National Park Service, Department of the Interior,
12795 W. Alameda Parkway, PO Box 25287, Lakewood CO 80225-0287
Attention: Planning Site and Facility Design, DSC Maintenance, Operations, and
Safety of Dams Program Coordinator, Richard L. Silva, Structural Engineer
(w/att)

Dan Kimball, Chief Water Resources Division
1201 Oak Ridge Drive, Suite 250
Fort Collins, CO 80525-5596
(w/att)

Southwest Support Office, Intermountain Region
National Park Service
U.S. Department of the Interior
P.O. Box 728
Santa Fe, NM 87504-0728
Attn: Maintenance, Design, and Engineering Office
Joe Bruno, NPS MOSD Program Contact
(w/att)

Regional Safety of Dams Officer, Bureau of Indian Affairs, Navajo Region, PO Box 619, Fort
Defiance, Arizona 86504
Attention: Chuck Nixon
(w/att)

Bureau of Reclamation, Native American Affairs, Phoenix Area Office, PO Box 81169, Phoenix,
Arizona 85069-1169
Attention: Kevin Black
(w/att)

HUBBELL RESERVOIR

Summary Data for Examination and Condition Survey Report

| Feature | National ID Number | NPS ID Number | Owner | Downstream Hazard Class (Note 1) | Public Safety Deficiency | Dam Safety Condition Code (Note 2) | O&M Condition Code (Note 3) | NPS Deficiency Code (Note 4) | SOP Available | EAP Available |
|-------------------|--------------------|---------------|---------------|----------------------------------|--------------------------|------------------------------------|-----------------------------|------------------------------|---------------|---------------|
| Hubbell Reservoir | AZ82914 | 645 | Navajo Nation | 3-Low | No | N/A | 4 | OT | No | No |

Explanations

O&M (Operation and Maintenance)
 SOP (Standing Operating Procedures)
 EAP (Emergency Action Plan)

Notes

See attached.

Date: 4/30/01

Refer to NPS DAMS INVENTORY USER GUIDE, revised July 1996, for explanation of data elements.
Refer to NPS Special Directive 87-4 and NPS-40 Guideline for help or call 202-565-1249.

- 1) NPS Number: 645
2) Dam ID: AZ82914
3) Region IMR - Intermountain Region
3.1) Support Office: DNSO - Denver Support Office
4) Park: HUTR - Hubbell Trading Post National Historic Site
5) NPS Organization Number Code: 7420

6) Name: ~~Noname Dam~~ *Hubbell Reservoir (formerly Noname Dam)*

7) Is this information about a dam?: Y - YES

8) Latitude (i.e. 37-17.10 ~~35-42.00~~ *35-42.4*)

9) Longitude (i.e. 076-38.50 ~~109-34.00~~ *109-33.3*)

10) Owner: ~~DO-NPS~~ *Navajo Nation, BIA*

11) Ownership: G - Federal Agencies other than the Corps of Engineers

12) Is project located within park boundaries?: ~~Y-YES~~ *N-NO*

13) Federally regulated: Y - YES

14) Purpose: I= IRRIGATION

Z= HISTORIC STRUCTURE

15) Type of Construction: *RE*

15.1) Year originally constructed:

15.2) Year last major corrective action:

16) Structural height in feet: 15

17) Maximum capacity in acre-feet: 20.00

18) Size class: 1 = Minor

Inspection Results and Corrective Action Information

19) Hazard Potential Classification: ~~2= Significant~~ *3-Low*

20) Organization(s) who prepared report: ~~WASO, BIA, SWRO, BR~~

21) NPS Inspector or Observer: ~~Karpowicz, G.~~

22) NPS Inspector/Observer Date of Training: ~~04/27/1995~~

23) Date of last inspection report completed: ~~04/02/1990~~

23.1) Data Record Approval:

24) Type of report: 4= Other

25) Is maintenance log being kept per NPS-40?: *N-NO*

25.1) Is project in NPS Maintenance Management System?:

Condition Classification

26) Has project ever failed or misoperated?: *N-NO*

27) U.S. Bureau of Reclamation Safety: -

28) NPS Operations/Maintenance: - *4*

29) All Outstanding Deficiencies OT= Other

30) Corrective Action Codes: *ON*

NPS Emergency Action Plan (EAP) Information per NPS-40

31) Date of Triennial Test of EAP:

31.1) Triennial Test Required? ~~Yes~~ *No*

32) Date of Annual Verification of NPS prepared EAP:

32.1) EAP Required? ~~Yes~~ *No*

33) Position Title of NPS EAP Coordinator: Chief Ranger

34) NPS 24-HR EAP Emergency Phone: ~~520-755-3475~~ *445*

35) Position Title of Local non-NPS EAP Coordinator: Ganado Fire Dept.

36) Local non-NPS 24-Hr EAP Emergency Phone: ~~520-755-3400~~ *445*

NPS Funding Information

37) Accumulative Funds Used or Obligated FY1980 - FY2001: 0

38) Accumulative Funds Programmed from FY2002 - FY2006: 0

39) Is facility funded for periodic maintenance and repair? N - NO

NA


2/20/02

40) Remarks: 16 & 17: Estimates. 19-2: Possibly significant hazard potential to downstream park areas. 20, 21, 23, & 24: Presence of dam revealed and discussed with C. Nixon, BIA & J. Bruno. 29-OT: establish inspection & maintenance & complete data elements. 30: Irrigation system being upgraded. 34: after hours ~~520-755-3752~~ *920*

41) Name of Park Reviewer:

43) Telephone:

44) Date data verified/edited:



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Location Map



Figure 1. Location of Hubbell Reservoir, from USGS topographic quadrangle "Ganado, Ariz."

Hubbell Reservoir

Literature Search and Review and Site Visit

Safety Evaluation of Existing Dams (SEED) Program - National Park Service (NPS)

Hubbell Reservoir

Hubbell Trading Post National Historic Site - Arizona

Prepared by Kevin Gagner, Civil Engineer, P.E.

This report documents a Literature Search and Review and site visit of Hubbell Reservoir (AZ82914)¹ {645}², which was performed on **May 16, 2001**, in the vicinity of the Hubbell Trading Post National Historic Site, Arizona. This report was prepared as the result of an interagency agreement between the National Park Service and the Bureau of Reclamation in accordance with the Departmental Manual, Part 753, NPS Management Guidelines-2001, NPS Special Directive 87-4, Dams and Appurtenant Works - Desk Reference Manual for Maintenance, Operation, and Safety, and NPS-40, Dams and Appurtenant Works: Maintenance, Operation, and Safety, Chapter 6, Section C, "Periodic Inspection Program".

The purpose of this site visit was to evaluate the condition of the dam and appurtenances, document any operation and maintenance concerns, obtain information for the NPS Dams and Streamflow Control Structures Inventory for Dams, and assess the public safety hazard potential at the site.

It was discovered during preparation of this report that the Navajo Nation anticipates rehabilitating the dam and reservoir for use as part of a larger irrigation system.

The cooperation and assistance provided by personnel from the Dam Safety Office, Bureau of Indian Affairs, Fort Defiance, Arizona during this site visit is appreciated.

This report reflects conditions at the time of the examination, and generally does not include changed conditions that may have occurred since that time.

¹Parentheses contain the National Inventory of Dams identification number for the dam.

²Curved brackets contain the NPS identification number for the dam.

A. Conclusions

An NPS operation and maintenance code of 4 (will not fulfill intended purpose and major repair or rehabilitation is needed), and the dam safety Downstream Hazard Potential classification code of 3 (low) assigned to Hubbell Reservoir as a result of the Downstream Hazard Classification performed in 1996 [1]³, are reflective of current conditions. The following conclusions were reached from a review of available data and a site visit.

1. The dam is classified as a downstream low hazard potential facility [1]. This classification is not a rating of the condition of the dam, but rather the potential loss of life and property if the dam were to fail. Failure of any of the dam embankments is not expected to jeopardize lives of persons at the Hubbell Trading Post National Historic Site downstream from the dam, or to cause significant property damage. However, some property damage may result from failure of the dam.

2. At the time of this field examination, the dam receives little or no periodic maintenance [LS-No Apparent Inspection and Maintenance Program]⁴, and the dam currently does not impound water. Although there is no evidence that the dam would fail should the reservoir fill, the resistance of the dam embankments to internal seepage-induced piping is unknown. If future storage of water is planned, the integrity of the embankment should be determined.

3. The low-level outlet is currently inoperable, and there is no means to evacuate the reservoir [OP-Operations and Maintenance]. It appears that much of the reservoir volume may be filled with silt, and that rehabilitation of any existing low-level outlet mechanical appurtenances may not be practical. If water storage within the reservoir is planned in the future, it may be necessary to install a new low-level outlet.

4. There is no spillway at Hubbell Reservoir. Because this is an offstream facility, construction of a spillway is not considered necessary.

B. Recommendations

None. However, if the dam and reservoir are rehabilitated, as anticipated, for use as part of a larger irrigation system, the resistance of the dam embankments to seepage-induced piping should be evaluated. If the anticipated rehabilitation includes increasing the reservoir storage volume by dredging or excavating silt, the low hazard classification [1] should be revisited.

³Numbers in brackets refer to references at the end of the report.

⁴Letters in brackets denote NPS deficiency codes.

SITE VISIT

A. Conditions During Site Visit

The weather on the day of the site visit (May 16, 2001) was dry, clear, and warm, with high clouds. The last measurable precipitation in the vicinity of the dam had fallen on May 14, 2 days prior to this examination. The precipitation did not affect conditions at the dam.

B. Description of the Dam

Hubbell Reservoir is an offstream facility impounded by four embankment segments that form a roughly rectangular reservoir area, and is located within the Navajo Indian Reservation, south of the Hubbell Trading Post National Historic Site in northeastern Arizona (see Figure 1). The period of construction, construction methods, and original dimensions are unknown. Dimensions in this description are estimates made during this field examination. The present reservoir volume is estimated to be 9 acre-feet, due to the siltation of the reservoir. The total estimated reservoir volume, including the portion filled with silt, is approximately 20 acre-feet. Rehabilitation of the dam and reservoir for future use as part of a larger irrigation system is anticipated by the Navajo Nation and Bureau of Reclamation (Reclamation).

The north embankment segment is the largest, and can be considered to be the main embankment. The north embankment has a maximum height of approximately 15 feet above the downstream toe, and a crest width of approximately 12 feet. The upstream faces of the embankment segments slope at approximately 3H:1V, and the downstream faces slope at approximately 2H:1V; there is no slope protection on any of the embankment segments except for sparse vegetation. The reservoir is approximately 400 feet long and 150 feet wide, and is approximately 6 feet deep at the maximum embankment section at its right downstream (northeast) corner; it appears that most of the reservoir has been filled with silt.

Evidently, water was formerly supplied to the reservoir from the intermittently-flowing ditch that runs parallel to the road and the south embankment segment. Two inlet headwalls, one each at the southwest and southeast corners of the reservoir, were discovered in the ditch during this examination. Both inlets were blocked, and no water is presently stored within the reservoir, except for periods when runoff through the ditch infiltrates the blocked inlets, or when direct precipitation collects within the reservoir. The remnants of a low-level outlet, consisting of a masonry headwall and what appears to be a gate stem extension, are located at the right downstream corner of the reservoir. There is no handwheel or other gate operating device at the low-level outlet. The inlet to the low-level outlet is blocked with silt; the outlet portal downstream from the embankment consists of two masonry training walls. There is no well-defined outlet channel, and there is no spillway for the dam.

C. Downstream Hazard Classification

Hubbell Reservoir is classified as a downstream low Hazard potential facility [1]. This classification is not a rating of the condition of the dam, but rather the potential loss of life and property if the dam were to fail. Dam-failure releases would discharge onto the flat terrain downstream from the reservoir, or into a wash at the east side of the reservoir, and are not expected to jeopardize the lives of persons at the Hubbell Trading Post National Historic Site located about 0.2 mile downstream. No major property damage is anticipated to occur as a result of dam failure, although some minor damage could be expected. This hazard classification is considered valid.

D. Condition of the Dam

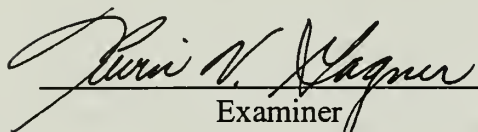
There is no cracking, settlement, or other sign of structural distress on the dam. No major erosion was observed on the embankments, even though slope protection is absent except for sparse vegetation on the embankment faces (photos 1 and 2). Although no serious deficiencies were visible during this examination, it should be recognized that the exterior appearance does not indicate whether the embankments were constructed with properly designed filter and transition zones and toe drains, or whether proper compaction methods were employed during construction. Trees and brush growing on and near the embankments (photos 3 and 4) are not desirable, but removal is not considered necessary because the reservoir does not currently store water, and removal would require breaching and reconstructing the embankment at locations of deep-rooted vegetation. The trunks and limbs from trees that were previously cut down on or near the north embankment segment are lying on the embankment crest as shown in photograph 3; removal is not necessary. Isolated animal burrows were observed on the north embankment segment (photo 5), but activity by burrowing animals did not appear to be widespread [LS-No Apparent Inspection and Maintenance Program].

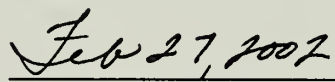
Water was supplied to the reservoir from the ditch between the road and the upstream embankment (photos 6 and 7) through inlets at the right (photos 6 and 8) and left (photos 9 and 10) ends of the upstream embankment. Releases were evidently made through the outlet works located at the right downstream corner of the reservoir shown in photographs 1 and 2. Outlet works discharges would flow onto the area downstream from the dam (photo 11) through the terminal structure, the remnants of which consist of two small masonry training walls shown in photograph 3. The low-level outlet is currently inoperable [OP]. There is no well-defined outlet channel downstream from the dam.

There is no spillway at this dam, and construction of a spillway is not necessary because this is an offstream facility. However, the right embankment slopes down to the elevation of the roadway upstream from the reservoir (photo 12); this would cause water to discharge into the wash on the right side of the reservoir (photo 13) in the unlikely event of high reservoir levels.

The Park's Facility Management Software System should be utilized to plan and record management of NPS and monitoring of non-NPS dams. Each dam should have a location code so that management can utilize the location report to identify all work activities performed on NPS dams or monitoring of non-NPS dams.

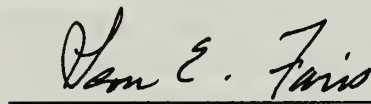
This report for Hubbell Dam was prepared in accordance with the Federal Guidelines for Dam Safety as implemented in Part 753 of the Departmental Manual.



Examiner


Date

Peer Review Certification

This report has been reviewed and is believed to be in accordance with the service agreement and standards of the profession.


Peer Reviewer


Date

SITE VISIT PARTICIPANTS

Kevin Gagner

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Bureau of Reclamation
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Leroy Yellowhair

Civil Engineering Technician
Bureau of Indian Affairs
Navajo Region
Fort Defiance, Arizona
(928) 729-7357

REFERENCES

- [1] "Downstream Hazard Classification Report, Hubbell Dam and Dike, Navajo Indian Reservation, Arizona," *Memorandum to Rodney Danzeisen, Client Liaison for BIA and Tribal Projects*, Bureau of Reclamation, prepared by Wayne J. Graham, Hydraulic Engineer, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, November 21, 1996.

Refer to NPS DAMS INVENTORY USER GUIDE, revised July 1996, for explanation of data elements.
Refer to NPS Special Directive 87-4 and NPS-40 Guideline for help or call 202-565-1249.

Page 1
Date: 4/30/01

- 1) NPS Number: 645
2) Dam ID: AZ82914
3) Region: IMR - Intermountain Region
3.1) Support Office: DNSO - Denver Support Office
4) Park: HUTR - Hubbell Trading Post National Historic Site
5) NPS Organization Number Code: 7420
6) Name: ~~Noname Dam~~ *Hubbell Reservoir (Formerly Noname Dam)*
7) Is this information about a dam?: Y - YES
8) Latitude (i.e. 37-17.10 -35-42.00 -35-42.4)
9) Longitude (i.e. 076-38.50 -109-34.00 -109-33.3)
10) Owner: ~~DOI-NPS~~ *Navajo Nation, BIA*
11) Ownership: G - Federal Agencies other than the Corps of Engineers
12) Is project located within park boundaries: ~~Y-YES~~ *N-NO*
13) Federally regulated: Y - YES
14) Purpose: I= IRRIGATION
Z= HISTORIC STRUCTURE
15) Type of Construction: *RE*
15.1) Year originally constructed:
15.2) Year last major corrective action:
16) Structural height in feet: 15
17) Maximum capacity in acre-feet: 20.00
18) Size class: 1 = Minor

Inspection Results and Corrective Action Information

- 19) Hazard Potential Classification: ~~2=Significant~~ *3-Low*
20) Organization(s) who prepared report: ~~WASO, BIA-SWRD~~ *BR*
21) NPS Inspector or Observer: ~~Karpowicz, G~~
22) NPS Inspector/Observer Date of Training: ~~04/27/1995~~
23) Date of last inspection report completed: ~~04/02/1999~~
23.1) Data Record Approval:
24) Type of report: 4= Other
25) Is maintenance log being kept per NPS-40?: *N-NO*
25.1) Is project in NPS Maintenance Management System?:

- 40) Remarks: 16 & 17: Estimates. 19-2: Possibly significant hazard potential to downstream park areas. 20, 21, 23, & 24: Presence of dam revealed and discussed with C. Nixon, BIA & J. Bruno. 29-OT: establish inspection & maintenance & complete data elements. 30: Irrigation system being upgraded. 34: after hours 520-755-3752
928

Condition Classification

- 26) Has project ever failed or misoperated?: *N-NO*
27) U.S. Bureau of Reclamation Safety: -
28) NPS Operations/Maintenance: - *4*
29) All Outstanding Deficiencies OT= Other
30) Corrective Action Codes: *ON*

NPS Emergency Action Plan (EAP) Information per NPS-40

- 31) Date of Triennial Test of EAP:
31.1) Triennial Test Required? ~~yes~~ *NO*
32) Date of Annual Verification of NPS prepared EAP:
32.1) EAP Required? ~~yes~~ *NO*
33) Position Title of NPS EAP Coordinator, Chief Ranger
34) NPS 24-HR EAP Emergency Phone: ~~520-755-3475~~ *520-755-3475*
35) Position Title of Local non-NPS EAP Coordinator, Ganado Fire Dept.
36) Local non-NPS 24-Hr EAP Emergency Phone: ~~520-755-3400~~

NPS Funding Information

- 37) Accumulative Funds Used or Obligated FY1980 - FY2001: 0
38) Accumulative Funds Programmed from FY2002 - FY2006: 0
39) Is facility funded for periodic maintenance and repair? N - NO

NA

2/20/02

41) Name of Park Reviewer:

42) Title:

43) Telephone:

44) Date data verified/edited:

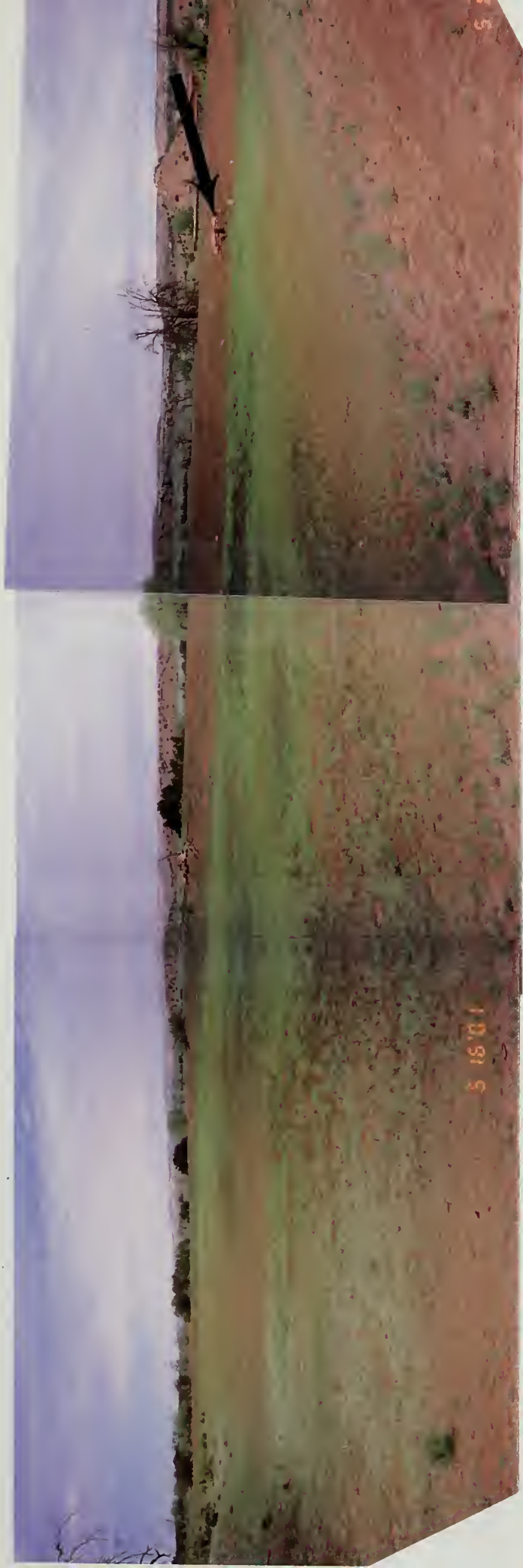


Photo 1. Hubbell Reservoir - Reservoir area viewed from the right upstream corner of the reservoir. The arrow indicates the low-level outlet at the right end of the downstream embankment. 5/16/01



Photo 2. Hubbell Reservoir - Reservoir area viewed from the right end of the downstream embankment. The arrow indicates the low-level outlet.

5/16/01



Photo 3. Hubbell Reservoir - Main (north) embankment, looking to the right (east). The upper arrow indicates a large tree growing on the downstream toe; the lower arrow indicates the masonry training walls that are the remnants of the low-level outlet terminal structure. 5/16/01



Photo 4. Hubbell Reservoir - Main embankment looking left. The arrows indicates trees and brush growing on the embankment crest and downstream toe. 5/16/01



Photo 5. Hubbell Reservoir - Animal burrow on the upstream edge of the main embankment segment.

5/16/01



Photo 6. Hubbell Reservoir - Southern embankment segment and supply ditch, looking to the left (west). The arrow indicates the right upstream reservoir inlet headwall. Note the large tree growing on the embankment.

5/16/01



Photo 7. Hubbell Reservoir - Supply ditch looking right (east) along the southern embankment segment. 5/16/01



Photo 8. Hubbell Reservoir - The arrow indicates the right upstream inlet to the reservoir also shown in photograph 6. 5/16/01



Photo 9. Hubbell Reservoir - Left reservoir inlet near the southwest corner of the reservoir, looking toward the reservoir. The arrow indicates the partially plugged inlet pipe. 5/16/01



Photo 10. Hubbell Reservoir - The arrow indicates the inlet to the reservoir at the southwest corner of the reservoir shown in photograph 9, looking from the west embankment segment toward the road. 5/16/01



Photo 11. Hubbell Reservoir - Flat terrain downstream from the main (south) dam embankment segment. The structures in the background are part of the Hubbell Trading Post National Historic Site. 5/16/01



Photo 12. Hubbell Reservoir - Right (east) embankment segment, looking to the east near the road. The arrow indicates where the embankment segment tapers toward the road. This low area would act as a spillway in the unlikely event of high reservoir surface elevations. 5/16/01



Photo 13. Hubbell Reservoir - Wash on the east side of the reservoir into which water would flow from the low area in the east embankment segment shown in photograph 12. 5/16/01

